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FROM

EXPERIMENT STATIONS

SEASON 1958-59

ADEN PROTECTORATE

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RESEARCH SECTION, EL KOD

Plant Breeding and Agronomy	K. R. M. Anthony, B.Sc., A.I.C.T.A.
Soil Science	J. E. A. Ogborn, A.R.I.C.
Entomology	J. H. Proctor, B.Sc., D.T.A.

ADEN PROTECTORATE

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PROGRESS REPORT FOR THE SEASON 1958-59

BY

K. R. M. ANTHONY, J. E. A. OGBORN and J. H. PROCTOR

Planting dates.	*Picking dates.*	*Close season.*
Mid August-mid October.	January-May.	June-mid August.

SUMMARY OF WORK

Abyan cotton now has an established reputation in the cotton trade and selection work is therefore concerned with the maintenance of varietal standards and improvement of lint yield per acre. The breeding policy is aimed at the transference of a high degree of resistance to Abyan root rot of cotton to the current Lambert strain. Amongst alternatives to the Lambert type, Wilds Early has been outstanding and the relative performances of other American long staple types need investigation.

In the Protectorates, cotton picking is sometimes delayed. A study has indicated that no serious loss in tensile strength occurs in lint exposed for a month to the weather of a normal picking season.

The mean cotton yield in Abyan could be increased if a higher standard of crop husbandry was practised. The work of the station has shown that further substantial yield advances can be attained in the northern half of the delta with sulphate of ammonia, applied at sowing. There is no evidence that the level of crop productivity is maintained by the annual deposit of flood-borne silt. Two seasons' results indicate that, where conditions are suitable, it is desirable to sow before irrigation.

Saline-alkaline soils have developed in parts of Abyan as a result of a high water-table, which is associated with over-watering of the land for crop production. Readings made of the depth of the water-table show that as a result of two successive seasons of low volume river flows there has been a general lowering of the water-table. It has been demonstrated that a single application of 30 cm. of water is sufficient to develop a commercial crop of cotton. Work with Farbrother resistance units has enabled an estimate to be made of maximum monthly totals of water loss by evapo-transpiration and drainage during the growing period of the cotton crop.

The entomological investigations have aimed at assessing the importance and studying the biology of *Diparopsis watersi,* the only bollworm of importance in the main cotton growing areas. Studies over the past two seasons indicate that the percentage of damaged bolls does not exceed 5 per cent. until February, by which time much of the crop has matured. The smallness of the loss due to *Diparopsis* is partly attributable to the low initial population in the crop. Egg

counts and light trap records indicate that emergence occurs before many buds are available on the crop. Under conditions of heavy and sustained attack on a crop of isolated cotton in one area, plants were kept substantially free of *Diparopsis* by 0·125 per cent. endrin applied to runoff at weekly intervals.

Of leaf insects, only *Aphis* is of any importance.

Work continued on Abyan root rot of cotton, both at Cambridge and Abyan, with a view to determining the identity of the causal organism, possible control measures and factors influencing the incidence of the disease.

Introduction

General

The funds necessary for the establishment and running of the Research Section in the period 1955-60 have been contributed by the Colonial Development and Welfare Fund, the Empire Cotton Growing Corporation, and the various cotton growing States in proportion to their cotton crops. The present budget ends on 31st March 1960, and thus during the year much thought has been given to planning and the framing of financial estimates for the next five-year period, 1960-65. Proposals have been submitted to the appropriate authorities.

An unhappy feature of the 1957-58 season was a general deterioration in security. However, during 1958-59 security progressively improved and by the end of the season had returned to normal. Survey work was therefore largely unrestricted, except that Yeramis and the Fadhli bedouin areas could be visited only as opportunity offered. It was again possible to dispense with an armed guard on journeys within Abyan.

No plant pathologist was available for studies on Abyan root rot in the Protectorate in the 1958-59 season, but we were fortunate in that Dr. W. J. Dowson has very kindly undertaken studies of the problem at the School of Botany, Cambridge. A note by Dr. Dowson on his experimental work is included in this report.

Mr. D. F. Ruston spent a few days at the station in November, for talks with staff and a tour of the Abyan and Lahej cotton areas. Amongst other visitors to El Kod were: Mr. J. J. Lawrie and Mr. W. Powell, Director and Agronomist, Department of Natural Resources, Somaliland Protectorate; Mr. C. Swabey, Forestry Adviser to the Secretary of State for the Colonies; Mr. E. Petrie, Development Commissioner; Professor Bardz of Bonn University; and the new Director of Agriculture, Aden, Mr. D. Watt-Smythe. Representatives of the various Farmers Cotton Producers Associations in Aden Protectorate spent two days at the station in December to acquaint themselves with the work in progress.

Mr. K. R. M. Anthony visited Somaliland Protectorate from 23rd September to 3rd October, at the invitation of the Department of Natural Resources, in order to see agricultural development and research projects in that territory.

Water Supply

The weather during 1958 was unusual; while rainfall in the coastal ranges of the Protectorates was higher than normal the High Yemen received much less. Consequently the flows in the wadi Bana and wadi Tiban, which drain this catchment area, were much reduced. The volume recorded at the wadi Bana headworks during July, August and September, 1958, was the lowest since records were started in 1948. Only 52 million cubic metres were received compared with the previous ten-year average of 99 million cubic metres. The flows were of low intensity and no floods went to the sea. Of the total, 7 million cubic metres passed the Bana headworks and were utilised on the west side of the wadi; 27 million cubic metres were used by the Batais canal and 18 million by the main canal and the Shagat ba Oma link canal. Though the intake of the main and Shagat ba Oma canals is at present limited artificially, it is nevertheless a valid measure of the steadily increasing efficiency of the Bana headworks that whereas during the kharif ('rains') of 1957 only 43 million of a total volume of 94 million cubic metres entered the headworks canals, no less than 45 million of a total of only 52 million cubic metres entered them during the kharif of 1958. Small floods of unknown volume also occurred in the wadi Hassan during this period and were utilised mainly in the areas to the east of this wadi.

The total watering efficiency in Abyan is estimated to have been just under 50 per cent. This is an increase of about 10 per cent. over 1957-58. It is probably near the maximum efficiency which the present system can attain without modification of the secondary irrigation works.

Southern Fadhli, including El Kod area and the El Kod station, received no flood water. This affected the research programme as a result of the enforced fallowing of the whole of Kod farm.

An estimated total of 95 million cubic metres of water was recorded in the wadi Tiban (Lahej) for the flood period. The whole of the floods under 50 cu.m.sec., amounting to 36 million cubic metres, was diverted into the canalisation system. With an estimated loss of 30 per cent. due to percolation, evaporation and breakages, approximately 25 million cubic metres were delivered to the fields and utilised for the cultivation of 6-7,000 acres of crops. For these data we are again indebted to Mr. F. H. Downing, Chief Engineer, Abyan Board, and Mr. J. J. Barraud, F.A.O. Irrigation Consultant.

The Cotton Crop

Owing to poor floods in the wadis Bana and Tiban, cotton acreages in Abyan and Lahej were below normal. In Abyan 14,000 acres of cotton were planted, compared with 25,000 acres last season. A final production of 10,000 bales of 400 lb. lint is expected, representing a yield of approximately 800 lb. seed cotton per acre. The acreage of cotton in Lahej fell from 13,500 acres in 1957-58 to 3,000 acres in the season under review. Yields were good, averaging nearly 1,400 lb. seed cotton per acre, and the State's total production will be approximately 3,700 bales.

As a result of above average rainfall in the coastal belt, some 11,000 acres of cotton were planted in the small outside areas, the unusually high total of 5,000 acres being planted in the Fadhli bedouin area utilising local runoff from high ground. However, yields from these areas have for the greater part been disappointing and their production will not exceed 4-5,000 bales, bringing the total Protectorate crop up to 17-18,000 bales, the lowest figure since 1952-53.

A summary of meteorological data at El Kod for the 1958-59 cropping season is given in Table 1. January and February were more overcast than usual, but a comparison with Aden Colony records shows that otherwise weather during the cropping season was in no way remarkable.

TABLE 1.

SUMMARY OF METEOROLOGICAL DATA

El Kod cropping season 1958-59

Month	*Temperature*		*Humidity*		*Sunshine*	*Wind*	*Rain*	
	max.	*min.*	*a.m.*	*p.m.*	*hours*	*miles/hr.*	*ins.*	*days*
September	96·8	79·0	81	64	9·0	4·53	—	—
October	92·5	71·2	75	57	10·1	4·63	—	—
November	86·7	66·6	82	56	10·7	4·87	0·24	1
December	84·2	69·4	83	61	9·4	5·75	Tr.	2
January	82·6	71·1	81	65	6·9	5·90	1·97	10
February	83·7	69·4	88	63	7·4	4·79	0·19	6
March	86·2	69·4	89	80	9·4	5·20	0·17	2
April	90·5	69·8	84	57	11·0	5·26	—	—

Grade was satisfactory and the mean grade of the Abyan crop is expected to be 3·5, with 82 per cent. of the crop in grades 2-4, of which 2,400 bales will be grades 2 and X2. The Lahej crop will grade a little lower, with a mean of 3·7 – 3·8, and the cotton from the other areas will bulk in grade 4. Picking standards are again far from satisfactory and there is room for very considerable improvement in most areas.

Crop sanitation in Abyan was bad and in mid June, at the time of writing, a considerable acreage of cotton was still unpulled. This in flagrant contravention of the regulations defining the closed season. Unfortunately, the greatest obstacle to agricultural development in the area remains the apathy of the local cultivators.

Plant Breeding

BY

K. R. M. ANTHONY

Cotton Selection and Propagation

To obtain information on the degree of variability of fibre strength to be expected within selected progenies, fibre bundle strength tests were made on 75 samples of material taken from the 1957-58 progeny testing plot, a 5 × 5 lattice square with three replications. The tests were carried out by the Shirley Institute, using both Stelometer and Pressley instruments. The trial mean for the Stelometer tests was 26·4 grammes per tex and for the Pressley tests 47·6. After elimination of block and progeny components the error correlation of the tests was only + 0·242. Correlation between progenies was + 0·642.

Simplified analyses, based on range, were carried out at the Shirley Institute. For each type of test two progenies, different in each case, showed statistically significant differences between plots. The widest range recorded for a progeny with the Stelometer tests was 3·3 (28·3 – 25·0) and with Pressley tests 2·9 (48·6 – 45·7). A comparison with plot records indicated a relationship between low Pressley figures and luxuriant vegetative growth, accompanied by *Aphis* and sooty mould.

Analyses of variance were also drawn up, based on the plot layout. With the Stelometer instrument, only the highest progeny mean (27·8) was significantly different from the control parent material (S.E. ± 0·54; coefficient of variation 2·5 per cent.). For the Pressley instrument, the range of progeny means was 46·3 – 48·8, no progeny having a reading significantly different from the control (S.E. ± 0·62; coefficient of variation 1·6 per cent.).

The 1958-59 progeny testing plot was in the form of a 7 × 8 rectangular lattice, with three replications, at El Kod. As no flood irrigated land was available plots were given a single watering from a tube well. Unfortunately, there was no other cotton nearer than eight miles and the resulting concentration of Sudan bollworm was sufficient to invalidate the trial, which will have to be repeated next season.

A 92 acres area of K1 will supply seed for a bulking area of 1,200-1,500 acres in the coming season. The rest of Abyan and the outside areas will be sown with BAR XL1 seed drawn from the Giar Yafai area.

Cotton Variety Trial

The cotton variety trial, a 10 × 10 Latin square with plots 40 sq. m. harvested, was sown at Giar farm on 27th August. Root rot was recorded on 66 of the plots, but the incidence remained low and plant stand was not appreciably affected, so that there was no significant

regression of lint yield on final stand. Lint yields are given in Table 2. Wilds Early again exhibited a marked superiority in productivity and its commercial possibilities are being explored. A 1·8 acre field of Wilds Early at Giar averaged 710 lb. lint per acre. Although it was considered undesirable to plant BAR XL1 on this site, because of the occurrence of root rot in previous seasons, the incidence of the disease on the Wilds Early was negligible. A small collection of American types has now been introduced from the Sudan and will be under trial next season.

Seed of two recent introductions, Pima S1 and Pima 32, was bulked for further trial. The first indications are that these varieties are probably unsuited to Aden Protectorate conditions, owing to high susceptibility to root rot and a plant structure of the Sakel type, with a tendency to lodge in high winds.

TABLE 2.

ABYAN COTTON VARIETY TRIAL 1958-59

	% *G.O.T.*	*Lint lb. per acre*	% *of control*
Wilds Early	33·7	543	175
AB3	34·0	405	130
K1	35·9	343	110
Karnak	34·3	318	102
AB Control	35·5	311	100
AB1	35·2	303	97
BAR XL3	35·0	299	96
BAR XL1	35·9	288	93
K2	35·1	268	86
Domains Sakel	32·2	215	69

S.E. means = ± 28 lb. per acre.

Abyan Root Rot of Cotton

A bulk of promising fifth backcross hybrid material (R1) was compared with Wilds Early and K1 for resistance to Abyan root rot in a randomised block experiment with five replicates on land where a high incidence of the disease had been recorded in 1955-56. Plot size was 50 planting points spaced 1 m. × 50 cm. and thinned to three plants per point. The final percentage mortality from root rot was 3 per cent. Wilds Early, 11 per cent. R1, 30 per cent. K1. An analysis of percentage data transformed to degrees was carried out, the percentage mortality for K1 being significantly greater than for Wilds Early and R1 at the 1 per cent. probability level, showing a good degree of resistance in the hybrid material. The difference between Wilds Early and R1 did not reach significance, but evidence from the breeding lines indicates that it was real.

An interesting feature of the trial was the high incidence of 'leaf rim blight' (*Aden Progress Report,* 1954-55, p. 5) on both R1 and K1, affecting respectively 18 and 19 per cent of the surviving plants. The

symptom is necrosis of the tissue around the edges of the leaves, which gradually spreads inwards and may possibly be associated with a non-fatal attack of the root rot organism.

Routine selfing and backcrossing to K1 of selected material continued.

Effect of Weathering on Cotton Fibre Strength

For various reasons, connected with neither crop nor climate, there has on occasions been a delay in starting picking in Abyan. In the 1957 season picking did not commence until late February, a delay of nearly four weeks. A similar, if less pronounced, delay occurred in 1956, whilst, as a result of unsettled conditions, the 1958 and 1959 crops were picked promptly. When picking is delayed it is reflected in the occurrence of mixed grades in cotton packs brought to the weighing stations and in a percentage of ground pickings. There is also the possibility of field damage to the lint and an investigation was undertaken, in co-operation with Mr. E. Lord of the Shirley Institute, to assess the degree of deterioration to be expected as a result of prolonged exposure to weather. Such deterioration is likely to be reflected in fibre strength, and therefore fibre strength measurements were made with the Stelometer instrument on lint samples exposed in open frames under different conditions of exposure and for periods up to 16 weeks. This trial was carried out during the normal picking season and repeated during the more extreme weather of a hot, humid Aden summer.

Results indicated that with maximum exposure to the normal weather conditions prevailing at picking time the loss in tensile strength of cotton fibre may approach 1 per cent. per week. However, it is probable that the bulk of the crop will average a smaller figure, and that the loss in strength will not be appreciable in cotton left unpicked up to four weeks. Under summer conditions the reduction in strength is more rapid and, with fully exposed cotton, may approach 2 per cent. per week. These latter conditions are not encountered in practice. A separate note on this investigation is being prepared for publication.

Agronomy

BY

K. R. M. ANTHONY and J. E. A. OGBORN

This was not one of the more successful seasons for field experimental work. A number of mishaps occurred and results were not as well defined and conclusive as had been hoped from last season's work. Owing to the enforced dry fallowing of the Kod farm, the bulk of the experimental work was undertaken at Giar.

Soil Fertility

Reference was made in the 1957-58 progress report to the rise in water-table in the lower fields of Giar farm, including that in which the rotation experiment is sited. On this experiment a visibly saline patch has appeared. The rise in ground water level probably results from overwatering in fields above the farm. With a reduction in the quantity of water applied to the whole area in 1958 there has been a satisfactory drop in the level of the water-table. However, unless this condition is maintained it is likely that the rotation experiment will have to be abandoned. Growth of the three crops on the experiment was uneven and variability high. The mean yield for cotton was 821 lb. seed cotton per acre with a response of +209 lb. per acre to nitrogen placed as sulphate of ammonia at the rate of 10 grm. nitrogen per square metre. Sorghum averaged 1,320 lb. grain per acre with a response of + 318 lb. to the same rate of nitrogen. Variability was such that neither response reached statistical significance.

A types of nitrogen experiment again compared sulphate of ammonia with urea, each at two levels, and no nitrogen. Fertilisers were applied by placement either to the side of or beneath the seed. That placed below the planting point proved to be too near the seed and resulted in germination failure. The replication of the remaining plots was inadequate to give a reasonably precise experiment.

An experiment comparing the presence with the absence of sulphate of ammonia, triple superphosphate and sulphate of potash on plots irrigated with silt-laden or silt-free water, and with cotton sown before or after irrigation, was laid down in a single replicate of 2^5 design. One half replicate was sited at Giar, the other at El Kod watered from a tube well but receiving silt transported from the silt-free plots at Giar. Fertilisers were each applied at the rate of 10 grm. per sq. m. of the main element. At El Kod the experiment suffered the depredations of Sudan bollworm referred to in the Plant Breeding and Entomology sections. Yields from this half replicate were negligible, and assessment of the responses was confined to height data, which were kept throughout the season. At Giar, cotton sown before irrigation provided tempting early fodder for the local goat population. This treatment is therefore omitted from the Table of effects, although resown plots were used in the evaluation of other treatment effects. With yield data available only from this half replicate the silt effect was entangled with the interaction of sowing time and nitrogen. Other main effects and interactions are given in Table 3.

At Giar, nitrogen was again clearly shown to be a major limiting factor, whilst responses to both phosphate and potash were negligible. On new land at El Kod there was no height response to nitrogen and it is probable that, had yield data been available, they would have shown

TABLE 3.

SOIL FERTILITY EXPERIMENT
Main effects and interactions

Giar (*lb. seed cotton per acre*)		*El Kod* (*height in cm. 20 December*)	
Nitrogen	+752***	Nitrogen	+ 2·8
Phosphate	+ 43	Phosphate	−10·3*
Potash	+ 44	Potash	− 7·9
Nitrogen × phosphate	−137	Pre-irrigation sowing	+20·9**
Phosphate × potash	+151	Nitrogen × sowing times	− 1·8
Standard error (7 D.F.[1])	±118	Nitrogen × phosphate	− 0·7
Mean yield	1260	Phosphate × potash	+ 0·3
		Standard error (7 D.F.)	± 4·3
		Mean height	75·8

[1]Degrees of freedom.

a similar lack of response. Plots sown before irrigation could readily be detected at a distance, and the response is probably linked with availability of water in the early growth stages. Whether in fact the significant negative height effect obtained with application of triple superphosphate was real and related to yield data is uncertain, but it appears that neither phosphate nor potash is in short supply in Abyan soils.

Another experiment at Giar compared the effect of burning debris on the land in the previous May (the time of cotton stalk burning) with no burning, in all combinations with sulphate of ammonia and none, triple superphosphate and none, and cotton sowing before and after irrigation. The rates of the two fertilisers were equivalent to 10 grm. per sq. m. of the main element. The layout used was a single replication of a 2^4 design in two blocks. Main effects and interactions are given in Table 4.

TABLE 4.

DEBRIS BURNING EXPERIMENT, GIAR
Effects and interactions

	Lb. seed cotton per acre
Nitrogen	+ 760*
Pre-irrigation sowing	+ 607
Burning	+ 15
Phosphate	+ 339
Nitrogen × burning	+ 275
Phosphate × burning	+ 224
Standard error (8 D.F.)	± 322
Mean yield	2170

Again the treatment sown before irrigation was damaged by goats and 54 per cent. of the total planting points of these plots had to be resown. Variability was consequently high (coefficient of variation 29·7 per cent.) and the subsequent yield effect of this treatment failed to reach significance. The early sown plants surpassed the others in height and

vigour from the beginning and indicated that this was a real effect, which would have been very substantial if plots had been undamaged. The nitrogen effect was large and significant and the effect of burning negligible.

Water Requirement of Cotton in Abyan

An experiment was laid down at Giar farm to compare the effect of four different rates of irrigation in the presence or absence of sulphate of ammonia, triple superphosphate and sulphate of potash with an additional contrast of sowing before irrigation versus sowing after irrigation. The site proved to be exceedingly variable, the uncorrected data giving a coefficient of variation of 56 per cent. As might be expected, responses were small and non-significant, but the information in Table 5 is informative.

Table 5.

Cotton water requirement experiment

Irrigation cm.	*Yield lb. seed cotton per acre*	*% blank planting points*
10	908	24
20	1079	18
30	920	16
40	687	17
S.E. means (7 D.F.)	178	10

The remarkable finding that, to obtain a commercial crop of cotton, a total of only 20-30 cm. of irrigation water need be applied confirms previous seasons' results.

The results of the bollworm damage experiment at El Kod were also of great interest. Total irrigations of 10 cm. and 30 cm. were applied to an initially dry profile. The heavy losses experienced in the half of the experiment unprotected by endrin made it necessary to analyse the growth of the crop in terms of total node production. A highly significant difference was noted between the two rates of irrigation, the yield of the higher rate being equivalent to a seed cotton production well above 2,000 lb. per acre. The actual yield of seed cotton from the endrin protected plots at the higher irrigation rate was 2,320 lb. per acre. At the lower rate of only 10 cm. production was still 780 lb. per acre, which is equal to the current commercial average in Abyan.

These results confirm previous experience that a single application of 30 cm. of water is sufficient to develop a cotton crop of average or above average size.

Abyan Root Rot of Cotton

If, as is supposed, Abyan root rot of cotton is caused by a soil parasite, then there is a possibility that soil sterilisation will effectively control the incidence of the disease. In a field experiment at Giar three chemical treatments, formalin, D-D and novo (a cresylic type soil steriliser), were compared with no chemical treatment, at two rates of water duty, 20 and 30 cm. Plots were split for no nitrogen and nitrogen at the rate of 10 grm. nitrogen per sq. m., and two varieties, K1 and Wilds Early. The sterilisers were applied immediately before irrigation. Owing to a delay in shipment, all were in short supply, and the rates applied to plots of 20 sq. m. were formalin 1,375 ml., D-D 250 ml., and novo 2,000 ml.

The spread of the disease followed the pattern described by Logan for the 1957-58 crop (*E. C. G. Review,* Vol. 35, p. 168). The first death from root rot was recorded on 9th October and thereafter there was an increase in incidence of the disease until the middle of November, followed by a decrease with practically no further spread after the end of December. The site chosen was adjacent to the 1957-58 steriliser experiment, in which plant deaths from root rot were 28 per cent. and 89 per cent. of the total initial population for Wilds Early and BAR XL1 respectively. In the 1958-59 experiment percentage mortalities were 5 per cent. and 31 per cent., in common with a general decrease in the incidence of the disease in the lower part of the Giar farm. An association with an observed drop in the level of the water-table is suspected. With a lower disease incidence, the occurrence of the disease was more variable than last year. An apparent reduction of mortality on the D-D plots did not approach statistical significance. The application of novo had no effect on mortality, and neither did formalin at this low rate of application. An increase of 60 per cent. in plant deaths with the higher watering rate also did not reach significance. Noteworthy was an apparent partial sterilisation effect with D-D, the mean yield of 1,296 lb. per acre being significantly greater than the mean of all other plots, 684 lb. seed cotton per acre.

Observations on other factors can be briefly summarised. In a study of its possible soil sterilising effect, bleaching powder hoed into the ground before watering at the rate of 390 grm. per sq. m. had no effect on the incidence of root rot, but resulted in stunted, bunchy cotton plants as a result of restricted growth of the internodes. Similarly, the incidence did not appear to be affected by the application of sulphate of ammonia.

Though triple superphosphate did not apparently affect the incidence of root rot in the bleaching powder experiment, it is worth recording that it appeared to increase deaths in the Giar water requirement experiment. The mean percentage mortality was 6 per cent., equivalent

to 4·3 deaths from root rot per plot. The presence of triple superphosphate produced a statistically significant increase of 2·8 deaths per plot.

The influence of moisture content in the upper part of the profile is shown in Table 6, also compiled from the irrigation experiment.

Table 6.

Total irrigation cm.	*Total plant deaths per plot*
10	2·8
20	4·8
30	2·5
40	7·4

S.E. = ± 1·29 (7 D.F.)

In a 4 × 4 Latin square, three treatments in which cotton was intercropped with cowpeas had a significantly lower number of plant deaths from root rot than the control treatment without cowpeas. Total mortality in the control treatment was 16 per cent. of the original stand. The relationship requires confirmation by further experimentation.

Outstations Experiments

An experimental programme was again undertaken in the Hadhramaut in co-operation with the resident Agricultural Officer. Results of three years of field experiments in the area indicate that economic yield responses can be obtained to the use of phosphate on wheat, particularly in the main wheat area of El Qatn. The Department of Agriculture will initiate a programme of extension work in the coming season. The use of fertilisers by Hadhrami farmers thus offers possibilities for the more efficient utilisation of limited land and water resources.

Soil Science

BY

J. E. A. OGBORN

Soil Moisture Changes under Cotton

Farbrother resistance units, available for the first time, were installed in experiments at Giar and El Kod and readings were taken throughout the season. It was immediately evident that of the two types of unit, plain and gypsum covered, only the latter could be trusted to give a reliable indication of soil moisture under Abyan conditions. These units gave results which were far more consistent from point to point than estimates based upon gravimetric sampling; that is to say, in a factorial experiment the standard error of any set of gravimetric samplings was much larger than that of the corresponding set of resistance readings converted to comparable dimensions. It was found

Table 7.

Changes in the moisture content of soil under cotton
1958/59
As cm. of water

Rainfall	*Oct.* 0	*Nov.* 0·6	*Dec.* 0	*Jan.* 5·0	*Feb.* 0·5	*Mar.* 0·4	*April* 0	*Total* 6·5	(*May*) 0
Plots receiving 30 cm. total irrigation									
0-50 cm. soil depth	−7·5	−0·6	− 2·1	+0·1	−0·8	−0·8	−0·3	−12·0	(−0·3)
50-100 cm. soil depth	−1·2	−0·6	− 3·6	+0·6	−0·7	−1·8	−1·2	− 8·5	(−1·3)
100-150 cm. soil depth	+1·0	−0·3	− 3·1	+0·1	−0·8	−0·3	−1·1	− 4·5	(−1·1)
150-200 cm. soil depth	+1·8	−0·6	− 2·3	−0·6	−0·2	−0·3	−1·0	− 3·2	(−1·0)
	−5·9	−2·1	−11·1	+0·2	−2·5	−3·2	−3·6	−28·2	(−3·7)
Plots receiving 10 cm. total irrigation									
0-50 cm. soil depth	−7·4	−0·6	− 1·1	+0·7	−0·3	−0·2	−0·6	− 9·5	(−0·8)
50-100 cm. soil depth	+0·1	−0·5	− 4·3	+1·9	−0·6	−0·8	−1·7	− 5·9	(−1·9)
100-150 cm. soil depth	−0·2	+0·2	− 3·9	+2·0	−0·8	−0·7	−1·6	− 5·0	(−1·5)
150-200 cm. soil depth	+1·5	+0·1	− 2·3	+0·8	−0·8	−0·8	−1·3	− 2·8	(−1·4)
	−6·0	−0·8	−11·6	+5·4	−2·5	−2·5	−5·2	−23·2	(−5·6)

necessary to calibrate the readings in terms of the volume/volume water content of each soil level of each experiment.

Though these calibrations were found to be approximately linear, the best fit was given by the form $W = A + BR + CR^2$, where R is the log resistance, W is the water content and A, B and C are empirical constants. Using a simple linear extrapolation it was possible to approximate the monthly moisture changes under the El Kod bollworm damage experiment. A more refined technique may possibly indicate the changes more accurately, but is unlikely to alter the relative dimensions of the moisture changes though the scale may need to be slightly reduced. This is because on this occasion a safety margin was allowed in the calculation of moisture changes, by making all the necessary approximations in the direction which gave the highest estimates.

The evident inaccuracy of the estimates may be seen in the record for January, during which the plots which received 10 cm. are recorded as gaining 5·4 cm. though the total rainfall was 5·0 cm.

Allowing for the rainfall received, the maximum estimated totals lost by transpiration, evaporation and drainage are indicated by Table 8.

Table 8.

Cumulative total of evapo-transpiration in cm.

	Oct.	*Nov.*	*Dec.*	*Jan.*	*Feb.*	*Mar.*	*April*
Plots receiving 30 cm. total irrigation	5·9	8·6	19·7	24·5	27·5	31·1	34·7
Plots receiving 10 cm. total irrigation	6·0	7·4	19·0	18·0	21·6	24·5	29·7

The calibrations for the Giar soils are not yet available.

Water-table Movement 1958-59

Studies of water-table movement continued and results showed that the effects of two successive seasons of low volume river flows have resulted in a widespread lowering of the water-table in Abyan.

Table 9 demonstrates the water-table movement as recorded in open wells in 1958-59.

Table 9.

Water levels in open wells, 1958-59

Metres below soil surface

	Period			*Drop in*
Well group	*May 1958*	*Nov. 1958*	*May 1959*	*W.T.*
Giar	6·65	5·50	6·83	+0·18
Dirgag marsh	2·44	2·30	3·25	+0·81
Hassan east	13·25	14·00	16·00	+2·75
Rumeila marsh	3·26	2·20	3·24	−0·02
Makhazan	6·01	5·60	6·85	+0·84
Means (weighted)	5·66	5·07	6·32	+0·66

It would appear that superimposed on the usual seasonal rise after the kharif floods there was a general fall of 66 cm. during the year

1958-59. This fall was consistent throughout the areas observed except the Rumeila marsh.

The water-table also fell at Giar Research Farm, as shown by Table 10.

TABLE 10.

WATER LEVELS IN OBSERVATION TUBES, GIAR FARM, 1958-59

Metres below soil surface

	Period			*Drop in*
	May 1958	*Nov. 1958*	*May 1959*	*W.T.*
Low fields	2·86	3·02	3·15	+0·29
Middle fields	3·54	3·64	4·35	+0·81
High fields	3·96	3·82	4·40	+0·44

The grid of observation tubes established in 1955-56 has now been almost entirely destroyed by malicious damage, and no useful information could be obtained from them in the current season.

ENTOMOLOGY

BY

J. H. PROCTOR

The autumn flood of 1958 failed to reach the southern part of the Abyan delta, and the cotton crop was therefore confined to the less accessible northern area. Routine monthly visits were made to the section between Giar and Dirgag and to the Husn, Halima and Batais districts. Less regular inspections were made of the crop in the Taria and Jebelein areas. At each visit a collection of bolls was made for subsequent examination.

Diparopsis watersi was the only bollworm of any importance in Abyan. No *Platyedra* were found, and only six specimens of *Earias* (two in the growing point early in the season) and five of *Heliothis*. The scarcity of *Heliothis* was evident also on *Dolichos lablab,* on which only ten specimens were found. *Earias* survives over the dead season principally in *Abutilon muticum,* which flowers sparsely throughout the summer and springs into rapid growth after the watering of the land. It fruits abundantly during the cotton season and *Earias* shows little tendency to abandon the *Abutilon* in favour of cotton. *Heliothis* was not found on any alternative hosts during the dead season.

Of leaf insects, *Aphis* did not appear until February and became numerous only in March. At El Kod, however, on cotton irrigated by tube well and growing in isolation from other cotton, it appeared in November, decreased, and increased once more in January, much sooty mould appearing on the plants. *Aphis gossypii* Glov. has now been recorded in Abyan on cotton, *Hibiscus esculentus, Solanum melogena,*

water melon and a wild cucurbitaceous species. Predators were active on the infested cotton at El Kod, including *Cheilomenes propinqua* Muls. (Coccinellidae) and species of Syrphidae and Chrysopidae. *Cheilomenes propinqua* and *Thea 16-notata* Muls. also attack *Aphis* on *Hibiscus esculentus.*

Empoasca occurred on cotton throughout Abyan, but serious leaf symptoms were seen only on plants of poor growth, and the effect on yield in general appeared to be slight. Two species of *Empoasca* occur in Abyan, *E. benedettoi* Paoli and *E. flavescens* (Fabr.). Both species have been found on *Solanum melongena* in gardens during the dead season, and *E. flavescens* has been found on *Solanum dubium.* The latter is a common weed of gardens and recently watered lands and with another species of *Solanum* is common on the banks of irrigation channels. *Solanum dubium* is an important host of *E. benedettoi* in the Sudan and its presence on watered land in and around gardens and perennial streams indicates its importance in the survival of jassids over the dead season. Specimens of *Empoasca,* not yet identified, also occurred in gardens over the dead season, on *Hibiscus esculentus* and *H. sabdariffa.*

Bemisia sp. was more common than last year, but only one instance of sooty mould due to whitefly was observed. The whiteflies tended to be very dense in small patches, and numbers rapidly dropped towards the end of December. *Podagrica puncticollis* occurred throughout the dead season on *Abutilon muticum* and *Hibiscus esculentus,* appearing on cotton in small numbers in November, but never causing any serious defoliation or damage to the bolls. *Sphenoptera gossypii* Cotes caused a certain loss throughout Abyan, but the greater proportion of plant deaths were due to root rot.

A visit was made to the cotton growing areas of the Eastern Protectorate. At Meifa'ah Wahidi, where the water-table is deep and the aspect that of an *Acacia* desert scrub, no bollworms were found. At Meifa Hajar, where the water-table is high, and the wadi flow perennial, *Earias* and *Platyedra* occurred but *Diparopsis* was not found. In addition to *Abutilon muticum, Earias* was also found in *Cienfugosia* sp. near *welshii,* a species found on pebbly land bordering wadis in the Wahidi-Hajar area. No bollworms were found in *Gossypium incanum,* a wild species found in the wadi Limbaraka in Wahidi and near Meifa Hajar, but the possible rôle of isolated scattered perennial cottons in maintaining *Platyedra* was indicated by the finding of *Platyedra* in a single group of kidney cottons in the village of Burum, some fifty miles from any annual cotton.

Diparopsis occurred (at Giar) in the first buds of the early budding variety Wilds Early in late September; in farmers' fields it was first found in early budding *punctatum* hybrids, which occurred in small

numbers. Though *Diparopsis* was found in all commercial cotton inspected, it was not until the middle of February, by which time much of the crop was finished, that boll damage exceeded 5 per cent. Thus, as in 1957-58, *Diparopsis* built up in the commercial crop too slowly to cause any very serious loss.

By contrast, some unsprayed cotton watered from the tube well at El Kod and growing in isolation was heavily attacked by *Diparopsis,* which emerged from the surrounding unwatered land, cropped with cotton the previous year, over a long period in November and December, when the cotton was starting to bud. Severe bud shedding seriously retarded flowering; it was only when some bolls had been set that the attack on the buds eased sufficiently to allow flowering to proceed. Heavy shedding then occurred in the maturing bolls, and the crop was greatly retarded and reduced.

The percentage of bolls damaged on this unsprayed cotton at El Kod was 21 per cent. at the end of February (when the corresponding figure for unsprayed cotton at Giar was only 5 per cent.) and 36 per cent. at the end of March. Total shedding as estimated from node and boll counts at the end of February was 80 per cent. for unsprayed and 46 per cent. for sprayed cotton at El Kod, and 48 per cent. for unsprayed cotton at Giar.

Spraying Trial at Giar

A detailed study of crop development and the loss caused by *Diparopsis* was made at Giar. Two areas, each of 500 square metres, were chosen in separate fields, and twenty plants were selected at random in each and tagged. One area was sprayed weekly with endrin emulsion at 1 lb. technical per acre, firstly at 32 gallons per acre and later, as the plants grew very large, at 64 gallons per acre.

Weekly counts were made of leaf insects on two upper, two middle and two lower leaves on each of twenty plants in each plot. The endrin greatly reduced the numbers of *Empoasca* and *Bemisia,* while *Aphis* did not appear in any numbers on either plot until March, when spraying ceased. *Ferrisiana virgata* (Ckll.) appeared in March and increased very much more rapidly on the sprayed than the unsprayed cotton.

In addition to the weekly plant diagrams, counts were made of fruiting points and daily flower production. The number of buds and bolls produced, as determined by the two methods, corresponded closely.

The sprayed cotton was of more vigorous growth than the unsprayed, the averages for fruiting point production and loss per plant and the percentage of buds and bolls shed being shown in Table 11.

Table 11.

Spraying trial, Giar

Fruiting point production and loss per plant

	Buds produced	*Buds shed*	*Bolls produced*	*Bolls shed*	*Bolls opened*	*Total shedding*
Sprayed	166·2	59·1 35·5%	106·4	21 19·7%	64·2	48·2%
Unsprayed	80·7	26·4 32·7%	58·7	15·9 27·1%	32·4	50·9%

Study of the shedding curves shows that the larger part of the total bud shedding in both the sprayed and unsprayed plots occurred in December during the development of the young bolls, while boll shedding occurred mainly in January when the bolls were maturing.

This indication that most of the shedding was natural was borne out by examination of shed buds and bolls collected weekly from the same two rows in each of the plots. The numbers of sheds collected corresponded closely with the shedding data given by the plant diagrams. The percentage of sheds damaged by *Diparopsis* remained low until the end of December, then increased more rapidly in the unsprayed than the sprayed cotton, and approached 100 per cent. in both during March. The overall percentage of shed buds damaged was 32 per cent. (sprayed) and 54 per cent. (unsprayed) and of the shed bolls 18 per cent. (sprayed) and 40 per cent. (unsprayed). Endrin thus appears to have given some protection against *Diparopsis* to both the buds and young bolls.

However, when the percentages of damaged sheds are applied to the shedding curves it emerges that in the unsprayed cotton most of the bud shedding in December and, to a lesser extent, of the boll shedding in January was natural, and *Diparopsis* became the principal cause of shedding only later, when the total shedding was very much less and the points lost could not have matured before the end of the crop. That most of the damaged buds shed in December would have been shed in any event is indicated by the percentage of buds shed, which was no higher for unsprayed than sprayed (Table 11). The loss due to *Diparopsis,* therefore, was limited to a small amount of shedding of young bolls and direct damage to older bolls, which boll collections in the unsprayed cotton at Giar and throughout Abyan indicated to be small.

Bollworm Damage Experiment at El Kod

The high concentration of *Diparopsis* on the isolated cotton at El Kod was utilised to conduct, in conjunction with the soil chemist, an experiment on the effect of heavy and sustained attack of *Diparopsis* on the development and yield of the crop, in relation principally to the availability of water. The following treatments were combined in

a 2^4 factorial design: a weekly spray of 0·125 per cent. endrin, applied to runoff; sulphate of ammonia at the rate of 10 grm. nitrogen per sq. m.; two sowing dates six weeks apart; and two rates of water duty, 30 cm. and 10 cm. A single replication was used, the third order interaction being confounded between the two blocks. Plot size was 2 m. × 2 m. with buffers of 1 m., four planting points per plot and two plants per point.

In addition to data recorded by the soil chemist and the final yield figures, records were kept of sympodial node production, boll production and numbers of bolls opened. Indices were thus obtained of the amount of bud and boll shedding, indicating the pattern of development of the crop. Records were also taken of the incidence of *Aphis gossypii.*

The results were submitted to the Statistics Department of the Rothamsted Experimental Station, whose assistance in their interpretation is gratefully acknowledged.

The main effect and interactions of endrin only are considered here. The severity of *Diparopsis* attack at El Kod is indicated by the overall effect of endrin, which was to increase plot yields nearly ten-fold. Weekly application of endrin at 0·125 per cent. to runoff kept the plants virtually free of *Diparopsis,* while the unsprayed plots showed a virtual crop failure.

Yield of seed cotton in relation to the numbers of fruiting points produced was less variable than the figures for yield per plot, and results were, therefore, considered in terms of yield per 100 sympodial nodes. These show the effect of *Diparopsis,* indicated by the response to endrin, to be a reduction in yield of 57 grm. per 100 nodes. There was a positive interaction between endrin and watering, loss being considerably greater with the high rate of water, indicating *Diparopsis* attack to be the most severe on the better-grown cotton.

Diparopsis reduces yield by causing heavy shedding of buds and, to a lesser extent, young bolls. The extent of shedding due to *Diparopsis* is indicated by the effect of endrin, which reduced the percentage boll shedding by 15, from 52 to 37 per cent.

The main effect of endrin, and also the interactions of endrin with amount of water and time of sowing, on the numbers of sympodial nodes produced (taken as an index of plant growth) are all negative, although not significant. This possible effect of endrin in depressing growth may well be indirect, as plants heavily attacked by *Diparopsis* and subject to heavy shedding continue to grow when the growth of sprayed plants has ceased.

Aphis gossypii was the only species of any importance besides *Diparopsis* in the experiment, and the endrin prevented its multiplication on the treated plots.

Diapause and Moth Flight

As the relation between emergence from long cycle pupae and the date of sowing of the cotton crop is a most important factor in determining the status of *Diparopsis,* the emergence of moths was investigated at Giar by means of egg counts and light trap records.

Eggs were found on the early budding Wilds Early as soon as buds appeared in late September; the numbers counted did not increase markedly from then on.

The light trap records are incomplete, as the trap was retained at Kod in expectation of the flood that did not come, and when the trap was installed at Giar in the middle of September large numbers of *Diparopsis* were taken at once, whereas catches were most infrequent during the summer months at El Kod.

The appearance of eggs on the Wilds Early and of moths at the light in the latter half of September indicated that an emergence occurred from the watered land around Giar before this time.

Last instar larvae, collected in the field at various times during the crop of 1957-58, were made to pupate in 4 inch diameter steel mesh cylinders sunk in the soil and protected from predators. Of 291 set to pupate only 128 (44 per cent.) have emerged as yet. The cylinders will be left to record any further emergence, and results to date are based on the assumption that equal mortality rates occur with long cycle and short cycle pupae.

The watering of the land was simulated by flooding the soil in which the cylinders were sunk by the El Kod tube well on 15th September. Table 12 records numbers of moths emerging, and these numbers as a percentage of the total emerging, in various months for larvae collected in January, February, March and April 1958. No further emergences have occurred since October 1958.

While the assumption that mortality rates are equal between long cycle and short cycle pupae may be wrong, there is some indication that the proportion of long cycle pupae formed increases as the season advances. Reliable meteorological data for the period before September 1958 are lacking, but it is doubtful if there is any considerable change in the diurnal temperature range over the period January-April with which the greater tendency to enter diapause may be connected, and it is certainly a period of rising maxima and minima.

Firmer conclusions can be drawn on the time of emergence from long cycle pupae. Soil temperatures at 2-4 inches during the summer are high and may well arrest diapause development. Flooding the soil in which the pupation cages were sunk caused a considerable drop of temperature—the mean temperature at 2 inches at noon over the nine days before flooding in mid September was 45° C., and over the nine days following flooding 32·7° C., the mean for October being

TABLE 12.

EMERGENCES FROM *Diparopsis* PUPAE SET TO PUPATE IN JANUARY-APRIL 1958, EL KOD

Larvae coll.	*Nos. emerged*	*Emergences in 1958*									
		Jan.	*Feb.*	*Mar.*	*April*	*May*	*June*	*July*	*Aug.*	*Sept.*	*Oct.*
Jan.	28 (32 set)	6 (21%)	21 (75%)	—	—	—	—	—	—	—	1 (4%)
Feb.	59 (147 set)	—	18 (30%)	36 (61%)	—	1 (2%)	—	—	—	—	4 (7%)
Mar.	19 (65 set)	—	—	11 (58%)	4 (21%)	—	—	—	—	—	4 (21%)
April	22 (47 set)	—	—	—	18 (82%)	—	—	—	—	—	4 (18%)

33·2° C. At 4 inches depth the average noon temperatures were 36·9° C. over the six days before flooding and 30·8° C. over the six days after flooding, with a mean for October of 30·1° C.

These results indicate that an emergence of moths from long cycle pupae takes place over the two months or so following watering, diapause development probably being arrested by high temperatures during the summer and resuming when the temperature drops on watering. The light trap records also indicate an emergence starting before the middle of September in an area where watering started in late July and early August. By contrast, emergence from the unwatered land round El Kod did not occur until November.

Cotton is sown as soon after the flood as the land permits, a matter of some ten days, and budding does not start in earnest for some two months after watering. The larger part of a moth flight occurring over the two months following watering will therefore be spent before buds are available and the initial infestation will be light.

The collection of last instar larvae from the 1959 crop for further pupation trials to confirm these conclusions has been seriously handicapped by the low initial infestation and the relative inaccessibility of the cotton areas, and only 66 larvae have been set to pupate.

ABYAN ROOT ROT

BY

W. J. DOWSON

The following note relates to inoculations with bacteria and fungi isolated from soil and diseased cotton plants sent to Cambridge from Abyan.

In December 1957, five cultures of bacteria were received which had been isolated by Logan in Abyan from the decaying roots of cotton plants affected by the root rot disease. Four of these were fast-growing soil saprophytes, but one corresponded in many of its biochemical and cultural characters with *Pseudomonas solanacearum,* the cause of the brown rot of the Solanaceae which also attacks other plants such as banana and groundnut. This pathogen gains entrance through the roots and is very common in tropical and sub-tropical soils with a constantly high water content. Inoculations were made with this organism and also with known virulent strains isolated from banana in Trinidad and from potato in Brazil.

Four varieties of fungi were isolated from the basal portion (collars) of plants sent to Cambridge. The plants were living, the upper portions still being green. The junction between the living and discoloured

innermost tissues of the stem yielded one fungus with aseptate hyphae, indicating the presence of a Phycomycete such as Pythium or Phytopthora. *Phytopthora parasitica* has often been isolated from a foot rot of cotton by Hopkins in S. Rhodesia where the soil was heavy and the season was very wet. Hence it was decided to inoculate plants with this species and two others, one from cinnamon and the other from betel pepper, which cause diseases similar to the Abyan root rot. Four different fungi were also isolated from a sample of soil taken from beneath diseased plants but have not yet been inoculated into cotton plants at Cambridge.

Inoculation Experiments

Not more than a dozen plants could be raised at any one time, owing to the limited space available in the glasshouses of the botanic gardens at Cambridge, to the director of which, Mr. J. S. L. Gilmour, thanks are due for permission to carry out the work and for making special arrangements for various degrees of temperature and humidity. The plants were grown either in John Innes compost or in a light sandy soil poor in organic content, and were kept rather moist. Those in the former soil grew much faster, but in both types of soil the plants were drawn to the roof. In the dull summer of 1958 the plants produced a few branches and a fair crop, but in the present exceptionally sunny conditions (1959) no branches have appeared after five months, which may be due to the length and intensity of daylight.

When the plants were about 18 ins. high, about six weeks after sowing, long slanting incisions were made in the collars about 1 in. below soil level so that the cortex and root bases were severed on one side. Into these wedge-shaped slits, pieces of agar plate cultures of the three species of Phytophthora and thick suspensions of three strains of *Pseudomonas solanacearum* were introduced. The wounds were then partially closed by pressing the edges together and covering with soil which was then watered. Check plants without inoculum were wounded in the same way. The three Phytophthoras were inoculated into each of the three plants with three controls. When a further twelve plants were ready some time later, five were inoculated with Logan's isolation of *Pseudomonas solanacearum* and five with the virulent strain from the banana or potato. Two were used as controls.

Results

Beyond a slight flagging of the lower leaves of the plants inoculated with *Phytophthora cinnamomi,* no adverse effect was produced and the inoculated plants were no different from the controls after five months, when it was concluded that under the conditions of the experiments none of the organisms introduced was pathogenic to cotton. It was,

therefore, decided to alter the method of inoculation in any future experiments and to grow plants in a soil heavily infected with *P. parasitica* which, as mentioned, is known to cause a foot rot of cotton under wet conditons.

At the time of writing, a further set of inoculations is in progress with the four previously mentioned fungi isolated from soil. Arrangements have also been made to send to Cambridge next October, when the disease will again have made its appearance, further specimens of collars of diseased but living plants.

Conclusions and Suggestions for Further Work

The fact that most of the diseased cotton plants at Abyan are grown in soil apt to be regularly waterlogged for a considerable time, and also that the soil water contains a relatively high concentration of salts, might suggest that the wilting and root rotting could be accounted for by these conditions alone. This, however, is partially offset by the occurrence of similar symptoms in drier areas not heavily waterlogged, whilst the spread of the disease in a circular manner also points to the presence and activity of a living agent.

There is evidently a very close connection between the amount of soil water, its salts, the water-table and the disease, factors which may well favour the activity of a pathogen. Similar conditions are certainly conducive to the attacks of *Pseudomonas solanacearum* in parts of Natal, where tomatoes are affected whenever grown, and also to the foot rot of cotton in Rhodesia already mentioned. The same is true of bananas in the West Indies where both *Ps. solanacearum* and the soft rot bacterium *Pectobacterium carotovorum* cause considerable losses.

Apart from the search for a likely pathogen it is suggested that some experiments be undertaken designed to investigate the effect of flooding alone, with disease-free soil. A series of tanks could be constructed and filled with soil on a considerable slope so that the water-table would be near or above the soil level at one end and much below it at the other end. The soil to be planted up and the amount of water and its salts could be varied in a series of such tanks. It could then be seen whether the disease symptoms were reproduced at the water-logged end.

PUBLICATIONS

Anthony, K. R. M. and Eyre, V. E. F.—"The Economics of Abyan Cotton Production". E. C. G. Review, 1959, Vol. 36, pp. 263-267.

Willimott, S. G. and Anthony, K. R. M.—"The Response of Eleusine to Different Forms of Nitrogen Fertilizer". E. J. Exp. Agric., 1958, Vol. 26, pp. 373-378.

Appendix

Key to symbols used in the report

AB Control	Rogued material from X1730A. Imported from the Sudan.
AB1	Bulked selections from Sudan-Egyptian X1730A.
AB3	Second bulk filter of AB1.
BAR XL1	An importation from the Sudan. First filter of BAR 1730L.
K1	First bulk filter of BAR XL1.
K2	Second bulk filter of BAR XL1.
BAR XL3	An importation from Sudan. Third filter of BAR 1730L.
Domains Sakel	An importation from the Sudan.
Karnak	An importation from Egypt.
Wilds Early	American long staple type imported from the Sudan.

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PROGRESS REPORTS FROM EXPERIMENT STATIONS

The reports for the seasons up to and including 1950-51 were published in seasonal volumes; the following are still in print and available at 3/- per volume post free.

1923-25 (one volume), 1926-27, 1931-32, 1934-35, 1935-36, 1942-43 and 1945-46 to 1950-51.

From 1951-52 the reports from each territory were published individually each season. A few of the 1951-52 reports are out of print, but all others are available post free at 1/- per report, or 7/6d. for the seasonal set.